IN THE CLAIMS

Please enter the amendments to the claims as shown below.

1. (currently amended) An electron source comprising:

an anode;

a cathode comprising a beam-receiving portion and an electron emitting portion, the beam-receiving portion having a substantially concave or substantially conical surface, the electron emitting portion having a tapered tip;

an electromagnetic radiation source adapted to generate an electromagnetic radiation beam to heat the cathode; and

a lens adapted to direct the electromagnetic radiation beam onto the substantially concave or substantially conical surface of the beam-receiving portion of the cathode,

whereby electrons are emitted from the electron emitting portion.

2-4. (cancelled)

5. (original) An electron source according to claim 1 wherein the electron emitting portion comprises tungsten.

6. (original) An electron source according to claim 1 wherein the cathode comprises a rod that terminates in the electron emitting portion, and wherein the lens is attached to the rod.

7. (original) An electron source according to claim 1 wherein the electromagnetic radiation source is adapted to heat the cathode to at least about 1800 Kelvin.

8. (original) An electron source according to claim 1 wherein the lens comprises aluminum oxide.

9. (original) An electron source according to claim 1 comprising an electromagnetic radiation detector to detect radiation reflected from the cathode to determine a property of the cathode.

10. (previously presented) An electron beam apparatus to register an electron beam pattern on a substrate, the apparatus comprising:

a vacuum chamber;

a substrate support to support a substrate;

an electron source to provide an electron beam in the vacuum chamber, the electron source comprising (a) an anode, (b) a cathode comprising a beam-receiving portion and an electron emitting portion, the beam-receiving portion having a substantially concave or substantially conical surface, (c) an electromagnetic radiation source adapted to generate an electromagnetic radiation beam to heat the cathode, and (d) a lens adapted to direct the electromagnetic radiation beam onto the substantially concave or substantially conical surface of the beam-receiving portion of the cathode; and

an electron beam modulator and scanner to modulate and scan the electron beam across the substrate to register an electron beam pattern on the substrate,

whereby electrons are emitted from the electron emitting portion.

11-13. (cancelled)

14. (original) An apparatus according to claim 10 wherein the electron emitting portion comprises tungsten.

15. (previously presented) An apparatus according to claim 10 comprising a rod that connects the lens and the beam-receiving portion of the cathode.

16. (original) An apparatus according to claim 10 wherein the electromagnetic radiation source is adapted to heat the cathode to at least about 1800 Kelvin.

17. (original) An apparatus according to claim 10 wherein the lens comprises aluminum oxid .

18. (original) An apparatus according to claim 10 wherein the electron source comprises an electromagnetic radiation detector to detect electromagnetic radiation emitted from the cathode to determine a property of the cathode.

19. (currently amended) A method of generating electrons from an electron source comprising an anode and a cathode, the cathode having an electron emitting portion and a beam receiving portion, the electron emitting portion having a tapered tip, the beam receiving portion having a substantially concave or substantially conical surface, the method comprising:

(a) negatively biasing the cathode relative to the anode to generate a localized electric field at the tapered tip of the electron emitting portion of the cathode; and

(b) heating the cathode by directing an electromagnetic radiation beam onto the substantially concave or substantially conical surface of the beam receiving portion of the cathode.

20-21. (cancelled)

22. (original) A method according to claim 19 comprising detecting a radiation reflected from the cathode and determining a property of the cathode.

23. (original) An electron source comprising:

an anode;

a cathode comprising an electron emitting portion having a tip, a beam-receiving portion, and a cathode axis;

a laser beam source adapted to generate a laser beam to heat the cathode; and

a lens adapted to focus the laser beam onto the cathode, the lens being supported by a rod that is substantially parallel to the cathode axis and terminates in the electron emitting portion of the cathode.

24. (original) An electron source according to claim 23 wherein the lens comprises a lens axis that forms an acute angle with or is substantially parallel to, the cathode axis.

25. (original) An electron source according to claim 23 wherein the beam-receiving portion is a different portion of the cathode than the electron emitting portion.

26. (previously presented) An electron source according to claim 23 wherein the beam-receiving portion comprises a substantially concave or substantially conical surface.

27. (original) An electron source according to claim 23 wherein the electron emitting portion comprises tungsten.

28. (original) An electron source according to claim 23 wherein the electromagnetic radiation source is adapted to heat the cathode to at least about 1800 Kelvin.

29. (original) An electron source according to claim 23 wherein the lens comprises aluminum oxide.

30. (original) An lectron source according to claim 23 comprising an electromagnetic radiation detector to d tect radiation reflected from the cathode to determine a property of the cathode.

31. (previously presented) A method of registering an electron beam pattern on a substrate, the method comprising:

(a) placing a substrate on a substrate support;

(b) generating an electron beam by (i) negatively biasing a cathode relative to an anode, and (ii) heating the cathode by generating an electromagnetic radiation beam and directing the electromagnetic radiation beam onto a substantially concave or substantially conical surface of a beam receiving portion of the cathode; and

(c) modulating and scanning the electron beam across the substrate to register an electron beam pattern on the substrate.

32-33. (cancelled)

34. (previously presented) An electron source comprising:

an anode;

a cathode comprising an electron emitting portion and a rod that terminates in the electron emitting portion;

an electromagnetic radiation source adapted to generate an electromagnetic radiation beam to heat the cathode; and

a lens attached to the rod and adapted to direct the electromagnetic radiation beam onto the cathode,

whereby electrons are emitted from the electron emitting portion.

35. (previously presented) An electron beam apparatus to register an electron beam pattern on a substrate, the apparatus comprising:

a vacuum chamber;

a substrate support to support a substrate;

an electron source to provide an electron beam in the vacuum chamber, the electron source comprising (a) an anode, (b) a cathode comprising an electron emitting portion and a rod that terminates in the electron emitting portion, (c) an electromagnetic radiation source adapted to generate an electromagnetic radiation beam to heat the cathode, and (d) a lens attached to the rod and adapted to direct the electromagnetic radiation beam onto the cathode; and

an electron beam modulator and scanner to modulate and scan the electron beam across the substrate to register an electron beam pattern on the substrat ,

whereby electrons are emitted from the electron emitting portion.

36. (previously presented) A method of generating electrons from an electron source comprising an anode and a cathode, the cathode having an electron emitting portion and a beam receiving portion, the electron emitting portion having a tapered tip, the method comprising:

(a) negatively biasing the cathode relative to the anode to generate a localized electric field at the tapered tip of the electron emitting portion of the cathode;

(b) directing an electromagnetic radiation beam onto the beam receiving portion of the cathode to heat the cathode; and

(c) determining a temperature of the cathode and adjusting the electromagnetic radiation beam to control the amount of heat applied to the cathode to maintain the cathode at a setpoint temperature.

37. (previously presented) An electron source comprising:

an anode;

a cathode comprising an electron emitting portion having a tapered tip;

an electromagnetic radiation source adapted to generate an electromagnetic radiation beam to heat the cathode;

a lens adapted to direct the electromagnetic radiation beam onto the cathode; and

a thermostat adapted to determine a temperature of the cathode and adjust the amount of heat applied to the cathode by adjusting the electromagnetic radiation beam,

whereby electrons are emitted from the tapered tip of the electron emitting portion.

38. (previously presented) An electron source comprising:

an anode;

a cathode comprising an electron emitting portion having a tapered tip;

an electromagnetic radiation source adapted to heat the cathode to at least about 1800 Kelvin by generating an electromagnetic radiation beam; and

a lens adapted to direct the electromagnetic radiation beam onto the cathode,

whereby electrons are emitted from the tapered tip of the electron emitting portion.

39. (previously presented) An electron source according to claim 1 wherein the cathode has a cathode axis, and wherein the lens has a lens axis that forms an acute angle with, or is substantially parallel to, the cathode axis.

40. (previously presented) An apparatus according to claim 10 wherein the cathode has a cathode axis, and wherein the lens has a lens axis that forms an acute angle with, or is substantially parallel to, the cathode axis.

41-42. (cancelled)

43. (previously presented) An electron source comprising:

an anode;

a cathode comprising an electron emitting portion and a beam-receiving portion, the electron emitting portion having a tapered tip, the beam-receiving portion consisting essentially of metal;

an electromagnetic radiation source adapted to generate an electromagnetic radiation beam to heat the cathode; and

a lens adapted to direct the electromagnetic radiation beam onto the beam-receiving portion of the cathode,

whereby electrons are emitted from the tapered tip of the electron emitting portion.

44. (previously presented) An electron beam apparatus to register an electron beam pattern on a substrate, the apparatus comprising:

a vacuum chamber;

a substrate support to support a substrate;

an electron source to provide an electron beam in the vacuum chamber, the electron source comprising (a) an anode, (b) a cathode comprising an electron emitting portion and a beam-receiving portion, the electron emitting portion having a tapered tip, the beam-receiving portion consisting essentially of metal, (c) an electromagnetic radiation source adapted to generate an electromagnetic radiation beam to heat the cathode, and (d) a lens adapted to direct the electromagnetic radiation beam onto the beam-receiving portion of the cathode; and

an electron beam modulator and scanner to modulate and scan the electron beam across the substrate to register an electron beam pattern on the substrate,

whereby electrons are emitted from the tapered tip of the electron emitting portion.

45. (previously presented) A method of gen rating electrons from an electron source comprising an anodc and a cathode, the cathode having an electron emitting portion and a beam receiving portion, the electron emitting portion having a tapered tip, the method comprising:

(a) ncgatively biasing the cathode relative lo the anode to generate a localized electric field at the tapered tip of the electron emitting portion of the cathode; and

(b) directing an electromagnetic radiation beam onto the beam receiving portion of the cathode to heat the cathode.

46. (previously presented) A method according to claim 45 comprising directing an electromagnetic radiation beam onto a different portion of the cathode than the electron emitting portion.

47. (previously presented) A method according to claim 36 wherein the setpoint temperature is at least about 1800 Kelvin.

48. (previously presented) A method according to claim 36 comprising negatively biasing the cathode relative to the anode at a voltage bias magnitude of about 1 kV to about 50 kV.

49. (previously presented) An electron source according to claim 38 comprising a voltage bias source capable of biasing the cathode to generate a localized electric field at the tapered tip of the electron emitting portion of the cathode.

50. (previously presented) An electron beam apparatus according to claim 44 comprising a voltage bias source capable of biasing the cathode to generate a localized electric field at the tapered tip of the electron emitting portion of the cathode.